SECTION 505 STEEL REINFORCEMENT

505.1 Description

(1) This section describes furnishing and placing bar steel, high strength bar steel or coated high strength bar steel.

505.2 Materials

505.2.1 General

(1) Use materials conforming to the requirements for the class of material named and specified below.

(2) Unless the plans show otherwise or the special provisions specify otherwise, use the deformed type for all bar steel, all high strength bar steel, and all coated high strength bar steel reinforcement. If plain, round steel reinforcement is specified, conform to ASTM A 675, grade 80 (550).

(3) Use fabrication tolerances for straight and bent bars specified in Subsection 4.3, Tolerances, of the American Concrete Institute Committee 315, in the American Concrete Institute Detailing Manual.

(4) Unless the contract specifies otherwise, submit a manufacturer's certified report of test or analysis showing the reinforcement conforms to the specifications to the engineer before incorporating the reinforcement into the work.

505.2.2 Bar Steel Reinforcement

(1) Conform to AASHTO M 31.

505.2.3 High Strength Bar Steel Reinforcement

(1) Conform to AASHTO M 31, grade 60 (420).

505.2.4 Coated High Strength Bar Steel Reinforcement

505.2.4.1 General

(1) Conform to 505.2.3 and the following coating requirements:

(2) The coating applicator must have an epoxy coating plant certification by the Concrete Reinforcing Steel Institute.

(3) Bend all bars that require bending before coating, unless the fabricator can bend the bar without damaging the coating.

505.2.4.2 Coating Material

(1) Use a department-approved powdered epoxy resin for the coating material.

(2) The epoxy resin manufacturer shall supply to the coating applicator, any information on the resin it considers essential to the resins proper use and performance as a coating. The resin manufacturer shall also furnish written certification that the material is the same formulation and quality as the material supplied for prequalification tests.

(3) The epoxy resin manufacturer shall provide patching or repair material, compatible with the coating and inert in concrete. This material shall be suitable for repairing areas of the coating damaged during fabrication or handling in the field.

505.2.4.3 Surface Preparation

(1) Ensure the bar surface is clean and free from rust, scale, oil, grease, and similar surface contamination, and slivers, scabs and other surface defects detrimental to proper coating.

(2) Blast the surface to a near white No. 10 finish according to SSPC-SP 10. Provide an anchor pattern with blast profile maximum roughness depth readings within the range of 1.6 mils to 4.0 mils (0.04 mm to 0.10 mm). Determine the readings according to NACE RP-287, using replica tape.

(3) Remove all traces of grit and dust from the blasting before coating.

(4) Apply the coating to the cleaned surface as soon as possible after cleaning and before visible oxidation of the surface occurs. The contractor shall not wait to apply the coating more than 8 hours after cleaning, unless the engineer directs otherwise.

505.2.4.4 Coating Process

(1) Apply the coating as an electrostatically charged dry powder sprayed onto the grounded steel bars using an electrostatic spray gun. The contractor may apply the powder to either a hot or a cold bar. Give the coated bar the thermal treatment the epoxy resin manufacturer recommends to provide a fully cured finished coating.

(2) Cure, post-cure, or cure and post-cure the coating film to a fully cured condition. The coating applicator shall check a representative proportion of each production lot, using the method it finds most effective for measuring cure, to ensure the entire production lot of coating is fully cured.

505.2.4.5 Test Bar Conditioning

(1) Condition all bars being tested for coating thickness, holidays (pinholes not visually discernible), coating adhesion, and abrasion resistance at a temperature range of 68 F to 86 F (20 C to 30 C). If disputed, conduct tests at 73 F +/- 4 F (23 +/- 2 C) and 50 +/- 5 percent relative humidity according to ASTM D 3451 Section 3.1.

505.2.4.6 Coating Thickness

(1) Ensure the coating is smooth and uniform in thickness. After curing is complete, ensure at least 90 percent of all recorded thickness measurements of the coating are 7 mils +/- 2 mils (0.25 +/- 0.05 mm). Thickness measurements below 5 mils (0.125 mm) are cause for rejection. The upper thickness limit does not apply to repaired areas of damaged coating. Measure the film thickness on a representative number of bars from each production lot according to ASTM G 12 for measuring film thickness of pipeline coatings on steel.

(2) Take an average of 3 individual readings on the body of a straight length of bar between 3 consecutive deformations to obtain a single recorded thickness measurement. Obtain a minimum of 5 recorded measurements, evenly spaced along 2 sides of the test bar for a minimum of 10 recorded measurements per bar.

(3) The contractor may use pull off and fixed probe gauges. Do not use pencil-type pull off gauges that require the operator to observe the reading at the instant the magnet is pulled from the surface. Follow the thickness gauge manufacturer’s recommendations for its calibration and use.

505.2.4.7 Coating Continuity

(1) Check the coating on a representative number of bars selected from each production lot after cure for continuity of coating and ensure it is free from holes, voids, contamination, cracks, and damaged areas. Additionally, ensure that not more than an average of 2 holidays exist in any linear foot (300 mm) of coated bar. Base the average on the bar’s full production length.

(2) Use a 67-1/2 volt holiday detector at the manufacturer's plant to check the coating.

505.2.4.8 Coating Flexibility

(1) Evaluate the coating flexibility based on a representative number of bars selected from each production lot. Evaluate coating adhesion according to paragraph 8.3.1 of AASHTO M 284M.

505.2.4.9 Abrasion Resistance

(1) Determine the coating’s resistance to abrasion on a representative number of bars selected from each production lot, according to ASTM D 4060 using CS-10 wheels and a 1000 gram load per wheel, and ensure that the weight loss does not exceed 100 megagrams per 1000 cycles.

505.2.4.10 Inspection

(1) Furnish a certificate of compliance for the surface preparation, coating material, and process. The coating applicator shall retain test results and make them available for not less than 7 years.

505.2.4.11 Damage Repair and Rejection

(1) The contractor shall not repair epoxy coated high strength bar steel reinforcement that does not conform to the requirements for coating thickness, continuity of coating, coating cure, or flexibility of coating. Replace or strip, reclean, and recoat the epoxy coating according to 505.2.4 epoxy coated high strength bar steel reinforcement with one or more of these defects.

(2) If using coated high strength bar steel reinforcement in bridges, the department requires patching on all circumferential areas with damaged coating, on all sheared or cut ends, on end areas left bare during the coating process, and on any areas that the entire coating is removed.

(3) If using coated high strength bar steel reinforcement in noncontiguous concrete pavement and in those miscellaneous concrete construction bid items in section 416, the department requires patching on all circumferential areas with damaged coating or removed coating. The department will not require patching on sawed ends, cut ends, coated damaged ends, or end areas left bare during the coating process.

(4) Perform patching with the material specified in 505.2.4.2 and according to the manufacturer's instructions.

(5) Complete required repairs before visible oxidation of the steel surface occurs.

(6) The engineer will reject bars having total damage greater than 2 percent of the total circumferential area of the bar length. Consider the entire loss of the coating at the specific area on the bar as total damage.

505.2.5 Welded Steel Wire Fabric for Concrete Reinforcement

(1) Use a fabric of the weight and design the plans show and conform to AASHTO M 55.

505.2.6 Dowel Bars and Tie Bars

505.2.6.1 General

(1) Furnish coated bars conforming to AASHTO M 31 M, grade 300 or 400. For dowel bars and straight tie bars, there is no requirement for bend tests. Ensure that the bars are the diameter and length the plans show.

(2) The contractor need not coat or patch sawed ends, sheared ends, cut ends, ends left bare during the coating process, or ends with damaged coating.

(3) The contractor need not repair circumferential coating damage from shipping, handling, or installation, if the following conditions are met:

1. The damaged area is 1/4 inch (6 mm) square or smaller.
2. The total damaged area in any one-foot (300 mm) length does not exceed 2 percent of the circumferential area in that length.

(4) Repair all areas of damaged circumferential coating larger than 1/4-inch (6 mm) square. Reject all bars with total damage greater than 2 percent of the bar's circumferential area.

505.2.6.2 Dowel Bars

(1) Coat dowel bars with a thermosetting epoxy conforming to AASHTO M 254, type B. The Concrete Reinforcing Steel Institute must certify the coating applicator’s plant. Ensure that the bars are straight, round, smooth, and free from burrs or other deformations detrimental to the free movement of the bar in the concrete.

(2) Saw or shear dowel bars to the required length. The department will allow shearing only if no damage occurs to the coating and shearing distortions do not exceed the following:

1. No distorted diameter is more than 0.04 inches (1 mm) greater than the true diameter.
2. No distortion extends more than 0.40 inches (10 mm) from the sheared end.

(3) Apply a surface treatment, or furnish manufacturer treated bars, capable of preventing bond between the epoxy-coated bars and the concrete. Apply field surface treatments when loading bars in the dowel bar magazine or after staking the dowel basket to the grade.

505.2.6.3 Tie Bars

(1) Coat tie bars as specified in 505.2.4 for coated high-strength steel reinforcement. Ensure that the tie bars are the shape the plans show.

(2) Repair, with compatible coating material, the bend location of field-straightened coated tie bars.

505.2.7 Continuous Concrete Pavement Reinforcement

(1) Provide reinforcing steel containing a minimum of 0.25 percent copper and conforming to AASHTO M 31. Use grade 60 (420) for longitudinal bars and grade 40 or 60 (300 or 420) for transverse bars.

(2) Coat all pavement reinforcement bars and metal bar chairs for continuous concrete pavement reinforcement as specified in 505.2.4, except as follows:

(3) There is no requirement to coat or patch sawed ends, sheared ends, cut ends, ends left bare during the coating process, or coated damaged ends.

(4) The contractor does not have to repair coating damage caused during shipping, handling, or installation, if the damaged area is 1/4 inch by 1/4 inch (6 by 6 mm) or smaller, and the total damaged areas in each one foot (300 mm) length does not exceed 2 percent of the circumferential surface area in the length. Repair all damaged areas larger than 1/4 inch (6 mm) square and reject all bars with total damage greater than 2 percent of bar circumferential surface area. The total circumferential surface area of the bar covered by patching material shall not exceed 5 percent.

505.3 Construction

505.3.1 Storage and Protection

(1) Store reinforcement above ground on platforms, skids, or other supports and protect from mechanical injury and deterioration from exposure. Use reinforcement plainly marked to facilitate inspection and checking. If placing in the work, ensure the reinforcement is free from detrimental dirt, dust, paint, oil, or other foreign material. The engineer will not reject reinforcement with rust, seams, surface irregularities, or mill scale if the weight, dimensions, cross-sectional areas, and tensile properties of a hand wire-brushed test specimen conform to AASHTO M 31.

(2) Use padded or non-metallic slings and padded straps for handling coated bar steel reinforcement. Store reinforcement on wooden cribbing and do not drop or drag it.

505.3.2 Bending

(1) Use bent bar reinforcement cold bent to the shapes the plans show, and unless the plans show otherwise or the engineer directs otherwise, conform to Recommended Hooks All Grades and Recommended Sizes for Stirrup and Tie Hooks, of the American Concrete Institute Committee 315. Ensure all bending dimensions are out-to-out of the bar.

505.3.3 Splicing

505.3.3.1 General

(1) Furnish bar steel reinforcement in the full lengths the plans show. Except where the plans show, do not splice reinforcement without the engineer’s written approval. The department will allow lapped splices, welded splices, mechanical couplers, or other connections the plans show or the engineer approves in writing. To the extent that it is practical, stagger splices in adjacent bars and locate splices as far as possible from the point of maximum tensile stress. The engineer will not allow splices at points that do not offer a minimum distance of 2 inches (50 mm) between the splice and the nearest adjacent bar, or design concrete cover the plans show at the splice location.

(2) Overlap the sheets of welded steel wire fabric to maintain uniform strength, and securely fasten at the ends and edges. Ensure the edge lap is at least one mesh wide.

505.3.3.2 Lapped Splices

(1) Ensure that lapped splices conform to plan requirements, are placed in contact with each other, and wired together to hold the bars in position for the full length of the splice.

505.3.3.3 Welded Splices

(1) The contractor may weld reinforcement only if the plans show welded splices or the engineer approves welded splices in writing. Use welded butt splices conforming to the AWS D 1.4, Structural Welding Code - Reinforcing Steel. Use electrodes conforming to AASHTO/AWS D 1.5 and submit electrode acceptance reports according to AASHTO/AWS D 1.5.

(2) Use AWS certified welders to perform all welding. If welder certification tests are required, a department-approved independent testing agency shall perform the testing. The engineer may require qualification tests according to AWS.

(3) Test 4 percent of the total number of splices per each bar size, but not less than 4 splices. For both qualification samples and production slices, conform to AWS radiographic methods and provide test results prepared by an inspector qualified under AWS to perform radiographic interpretation.

505.3.3.4 Bar Couplers

505.3.3.4.1 General

(1) Provide threaded bar couplers unless the engineer approves an alternate coupler system in writing as allowed under 505.3.3.4.3.

(2) If splicing epoxy coated bars, clean and coat couplers and exposed threads with epoxy. Couplers may be coated with epoxy before or after installation. Use epoxy that is compatible with the touchup epoxy used on coated reinforcing bars.

505.3.3.4.2 Threaded Bar Couplers

(1) Ensure that the threaded bar coupler material is capable of developing 125 percent of the yield strength of the bar being spliced. Provide a manufacturer certified report of tests, based on a minimum of 3 tests, showing the threaded bar coupler capacity.

505.3.3.4.3 Alternate Bar Coupler System

(1) Do not install alternate bar coupler systems before department proof testing and without the engineer's written approval. Provide 3 sample splices to the department for testing. Conform to the manufacturer's installation instructions and provide a copy of those instructions to the engineer.

505.3.4 Placing and Fastening

(1) Place steel reinforcement precisely in the position the plans show and hold firmly during the concrete placing and setting by using spacer strips, stays, recycled plastic chairs, metal chairs, or other engineer-approved devices or supports. If using recycled plastic chairs, use them only to support the bottom layer of steel reinforcement. Unless provided otherwise, use coated high strength bar steel reinforcement in the top layer of reinforcement in the concrete deck.

(2) Make metal chairs from stainless steel, steel that is zinc coated or epoxy coated after fabrication, or from uncoated steel with engineer-approved plastic tipped legs, or with at least 1/2 inch (13 mm) of the bottom of the legs hot dip zinc coated or plastic-coated. Furnish epoxy coated metal chairs or recycled plastic chairs to support coated high strength bar steel reinforcement, subject to the plastic chair restriction stated above. The epoxy coating thickness shall conform to 505.2.4.6.

(3) Use recycled plastic chairs manufactured from recycled plastic obtained from post consumer products. Ensure they are chemically inert in concrete and are molded in a shape that does not restrict concrete flow and consolidation around and under the chairs.

(4) For recycled plastic chairs conform to the following requirements within a temperature range of 20 F to 150 F (-7 C to 66 C):

PROPERTY	VALUE	ASTM TEST
Minimum shear strength	5000 psi (3405 MPa)	D 732
Minimum compressive strength	10,000 psi (69.0 MPa)	D 695M
Maximum water absorption	0.1 percent	D 570

(5) Support bar steel reinforcement in the concrete decks and slab spans as follows:

1. For all decks and slab spans, support bottom transverse bars with continuous bar chairs spaced 4 foot (1200 mm) on centers or closer. Support the ends of the bars with a line of chairs near each deck or slab edge.
2. On decks less than 12 inches (305 mm) thick, support top longitudinal bars with continuous bar chairs spaced 4 foot (1200 mm) on centers or closer. Provide a row of continuous bar chairs directly under each row of transverse bar splices.
3. On decks and slab spans 12 inches (305 mm) thick or thicker, support top transverse bars with individual supports spaced approximately 3 foot (914 mm) on centers or closer in both directions. Use either individual bar chairs setting on the form floor or bent reinforcement bars supported off the bottom mat. Support bars near the edge of the deck or slab with individual supports spaced 3 foot (914 mm) on centers or closer.

(6) The contractor may use precast concrete bricks or other engineer-approved bricks or blocking in structures to support reinforcement in footings or slabs placed on grade; however, the bricks or blocking shall not contact the reinforcement over a distance greater than the depth of a standard concrete brick. Tie the upper layer of reinforcement for bridge decks securely to the girders or forms at a longitudinal spacing not greater than 8 feet (2.44 m). For decks of slab span bridges, the ties shall have a transverse spacing not to exceed 8 feet (2.44 m), and for decks over girders, secure the ties to or next to each longitudinal line of girders.

(7) Tie the bars securely at all intersections except if spacing is less than one foot (300 mm) in each direction, if alternate intersections are tied. The contractor shall not use tack welding to tie steel. Before placing any concrete in a unit or section, obtain the engineer's approval of the reinforcement placing and securing in that unit or section.

(8) Tie coated bars using a procedure, equipment, and materials that will not damage or cut the coating. Tie coated reinforcement with one of the following:

1. Ties made from an engineer-approved plastic or nonmetallic material.
2. Stainless steel wire.
3. Nylon, epoxy, or plastic-coated wire.

505.4 Measurement

(1) The department will measure the Bar Steel Reinforcement bid items by the pound acceptably completed. The department will compute the bar weight from the nominal weights for corresponding sizes for deformed bars in AASHTO M 31M. The department will not measure the extra metal used if the contractor chooses to substitute bars larger than those specified, the extra metal necessary for splices the plans do not show, or the weight of any devices used to support or fasten the steel in its correct position.

(2) The department will measure the Bar Couplers bid items as each individual coupler acceptably completed.

505.5 Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
505.0105	Bar Steel Reinforcement Bridges	LB
505.0110	Bar Steel Reinforcement Culverts	LB
505.0115	Bar Steel Reinforcement Retaining Walls	LB
505.0405	Bar Steel Reinforcement HS Bridges	LB
505.0410	Bar Steel Reinforcement HS Culverts	LB
505.0415	Bar Steel Reinforcement HS Retaining Walls	LB
505.0605	Bar Steel Reinforcement HS Coated Bridges	LB
505.0610	Bar Steel Reinforcement HS Coated Culverts	LB
505.0615	Bar Steel Reinforcement HS Coated Retaining Walls	LB
505.0900-0919	Bar Couplers (size)	EACH

(2) Payment for the Bar Steel Reinforcement bid items is full compensation for providing, transporting, and placing all reinforcement including supports. Where the plan specifies bar couplers, the department will pay for the length of bars as detailed with no deduction or increase for installation of the coupler.

(3) Payment for the Bar Steel Reinforcement HS Coated bid items also includes coating, including epoxy coated metal chair supports.

(4) Payment for the Bar Couplers bid items is full compensation for providing couplers, including bar steel that is part of the coupler and not detailed in the plan; for threading reinforcing bars; for installing and coating the splice; and for supplying and testing 3 couplers.